Single Top analysis

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Single top study

$$\mathscr{L}_{Wtb} = \frac{g}{\sqrt{2}}\left[W_\mu \bar{t}\gamma^\mu (V_{tb} f_1^L P_L + f_1^R P_R) b - \frac{1}{2\,m_W} W_{\mu\nu}\bar{t}\sigma^{\mu\nu}(f_2^L P_L + f_2^R P_R) b\right] + h.c.$$

where $f_1^L \equiv 1 + \Delta f_1^L$, $W_{\mu\nu} = D_\mu W_\nu - D_\nu W_\mu$, $D_\mu = \partial_\mu - ieA_\mu$,
$\sigma^{\mu\nu} = i/2\,(\gamma^\mu\gamma^\nu - \gamma^\nu\gamma^\mu)$.

In SM $|V_{tb}| f_1^L \approx 1$ and at tree level $\Delta f_1^L, f_1^R, f_2^L$ & f_2^R vanishes.

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Hadronic Channel:
sig: p e- > ve t~, W > j j :    1.034 pb
ccjjb: p e- > ve j j b :        0.073 pb
ccjjj: p e- > ve j j j :        27.40 pb
ncjjb: p e- > e- j j b :        2.84  pb
ncjjj: p e- > e- j j j :        311.6 pb
chad : p e- > ve c~, W > j j:   0.0194 pb
f1l=0.5:  2.32 pb
f1r=0.5:  1.38 pb
f2l=-0.5: 1.07 pb
f2l=0.5:  1.48 pb
f2r=0.5:  1.68 pb

Leptonic Channel:
sig: p e- > ve t~, W > l vl :   0.346 pb
cclvb: p e- > ve l vl b :       0.0059 pb
cclvj: p e- > ve l vl j :       0.2096 pb
nclvj: p e- > e- l vl j :       0.434 pb
clep : p e- > ve c~, W > l vl:  0.0063 pb
f1l=0.5:  0.776 pb
f1r=0.5:  0.447 pb
f2l=-0.5: 0.322 pb
f2l=0.5:  0.472 pb
f2r=0.5:  0.566 pb
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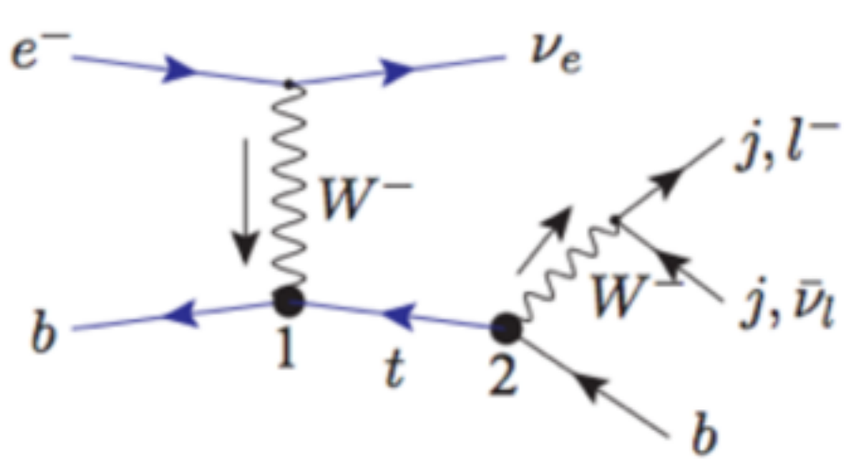


- Measure delta f1L, f1R, f2L, f2R
- f is real
- Delphes-LHeC simulation.

Cut flows

- Hadronic:
  - 1b jet, |eta|<3, pt>20GeV
  - 2 light jets |eta|<5 pt>20GeV
  - light jets are separated from b jet by dR>0.4
    - MET>25GeV, dphi MET with b, j >0.4
    - Mjj in M_W window in 22GeV
- Leptonic:
  - 1b jet, |eta<3|, pt>20GeV
  - 1 lepton, pt>10GeV, |eta|<2.5
  - MET>25GeV, dphi MET with b, lepton>0.4

Cut Flows

- Hadronic (SM, particle agrees well, parton has higher efficiency, as expected)

Printing the cut flows: (Weights@1e+03fb-1)											
Samples	SM	f1l0.5	f1r0.5	f2l-0.5	f2l0.5	f2r0.5	Backgroun	parton	particle	parton*0.7	particle*0.824
010_INIT	1.86e+06	4.18e+06	2.48e+06	1.93e+06	2.66e+06	3.03e+06	2.89e+09	1.86E+06	1.86E+06	1.86E+06	1.86E+06
010b_1bjet_cand	1.3e+06	2.92e+06	1.74e+06	1.35e+06	1.8e+06	2.15e+06	6.58e+07	1.8E+06	1.85E+06	1.3E+06	1.52E+06
020_1bjet	1.3e+06	2.92e+06	1.74e+06	1.35e+06	1.8e+06	2.15e+06	6.57e+07	1.8E+06	1.5E+06	1.3E+06	1.2E+06
030_1bjet_twojet	7.89e+05	1.79e+06	1.09e+06	7.77e+05	1.22e+06	1.33e+06	8.65e+06	1.4E+06	9E+05	9.8E+05	7.416E+05
040_EtMiss	6.23e+05	1.4e+06	8.66e+05	6.25e+05	1.03e+06	1.12e+06	5.96e+05	1.09E+06	7.1E+05	7.63E+05	5.9E+05
050_dphiMET	4.94e+05	1.1e+06	6.88e+05	5.03e+05	8.38e+05	9.08e+05	3.73e+05	8.52E+05	5.59E+05	5.96E+05	4.61E+05
060_invMass	3.8e+05	8.48e+05	5.32e+05	3.82e+05	6.39e+05	6.88e+05	1.32e+05	8.47E+05	4.37E+05	5.93E+05	3.60E+05

- Leptonic (SM, parton, particle agrees well)

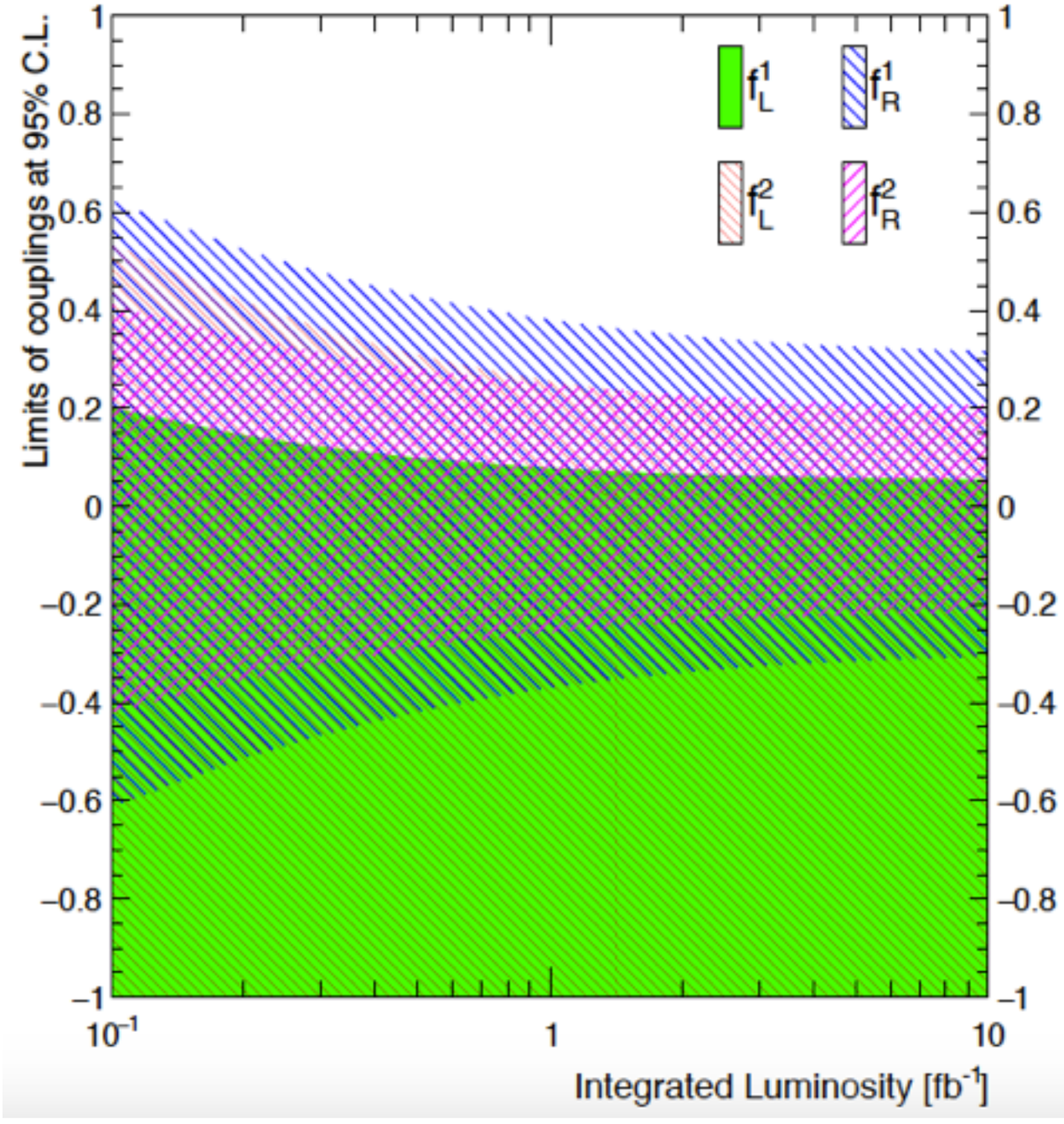
Printing the cut flows: (Weights@1e+03fb-1)											
Samples	SM	f1l0.5	f1r0.5	f2l-0.5	f2l0.5	f2r0.5	Backgroun	parton	particle	parton*0.7	particle*0.824
010_INIT	6.22e+05	1.4e+06	8.04e+05	6e+05	1.02e+06	8.5e+05	2.67e+06	6.22E+05	6.22E+05	6.22E+05	6.22E+05
010b_1bjet_cand	4.22e+05	9.52e+05	5.5e+05	4.02e+05	6.78e+05	5.86e+05	3.96e+04	6.01E+05	5.11E+05	4.21E+05	4.21E+05
020_1bjet	4.21e+05	9.5e+05	5.49e+05	4.01e+05	6.77e+05	5.85e+05	3.94e+04	6.01E+05	4.93E+05	4.21E+05	4.06E+05
030_1bjet_1lep	3.45e+05	7.8e+05	4.45e+05	3.18e+05	5.55e+05	4.83e+05	3.14e+04	4.94E+05	4.04E+05	3.46E+05	3.33E+05
040_EtMiss	3.02e+05	6.84e+05	3.89e+05	2.77e+05	4.81e+05	4.21e+05	2.38e+04	4.38E+05	3.6E+05	3.07E+05	3.0E+05
050_dphiMET	2.85e+05	6.45e+05	3.66e+05	2.6e+05	4.51e+05	3.91e+05	2.16e+04	4.14E+05	3.39E+05	2.90E+05	2.79E+05

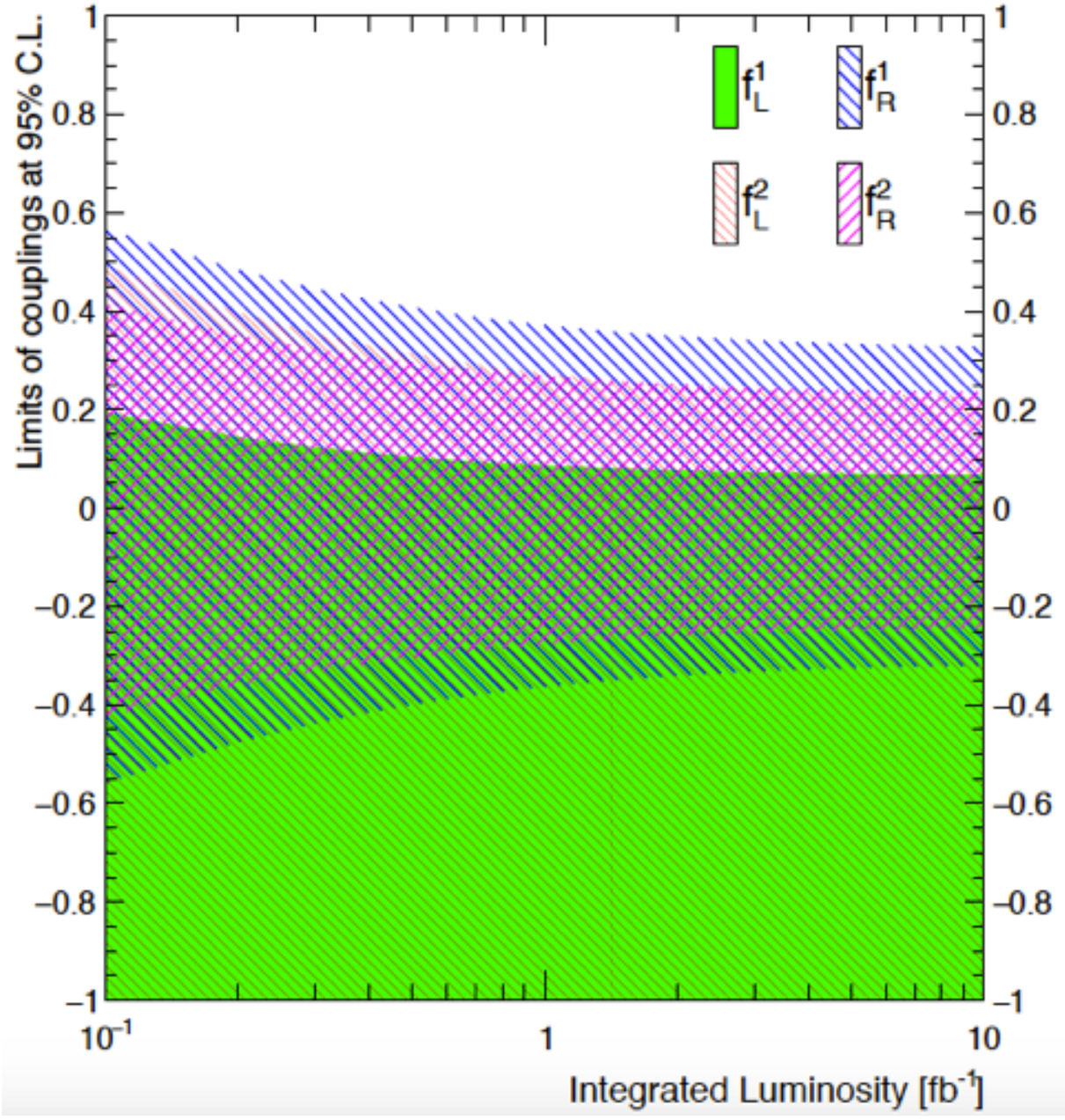
Comments on cut flows

- Signal/background (SM+background) ~ 1/2
- very sensitive in high luminosity, e.g. 10 fb-1
- Cut flow is very efficient to suppress backgrounds, including photon production, almost pure signal.
- Leptonic has higher purity, hadronic has better discriminant variables in different BSM models.
- Parton/Particle/Jets study is consistent.

Statistical result

- Using signal/background events only
- Signal: f coulping - SM; background: SM+all background.
- Poisson counting experiment
- Assuming 5% systematic uncertainties on both signal and background
- Obtain limit on the cross section, then translate to the couplings.

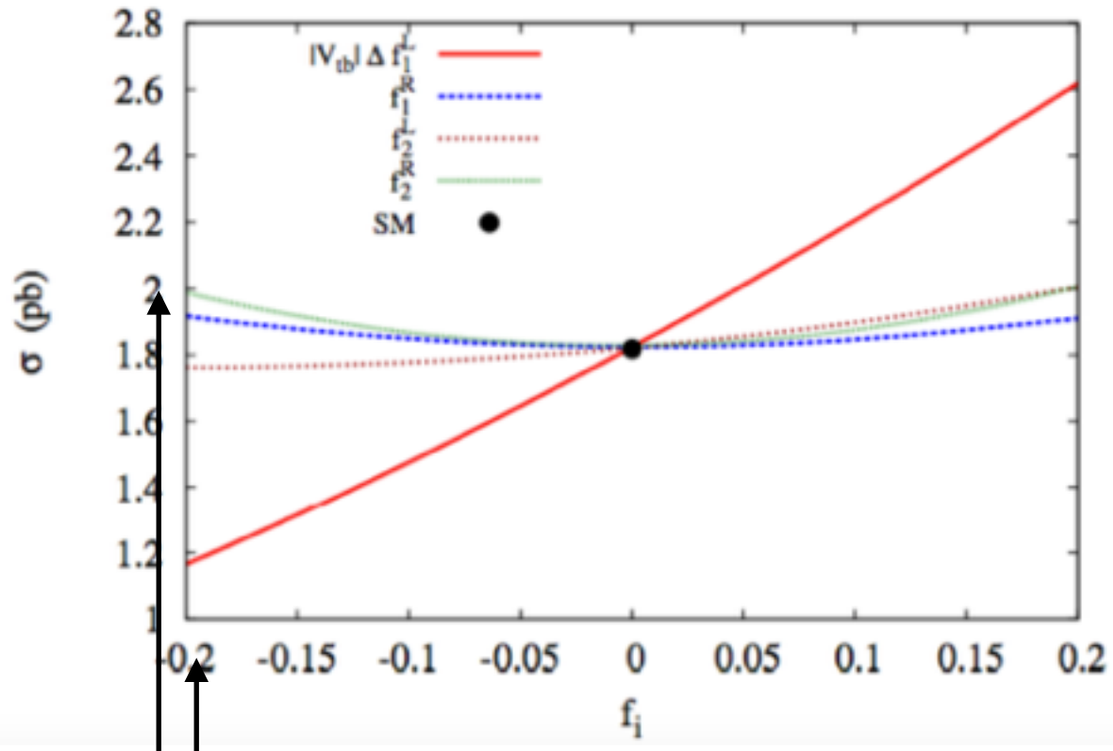




- Limits dependence on leptonic (left) and hadronic (right) case

Comments on the statistics

- The analysis is very sensitive at 10 fb-1
- Increasing luminosity doesn't help, totally decided by the systematic uncertainties.
- eg for 10 ab-1, the 95% limit is roughly the SM cross section * 1+ (systematic*2), that is 1.10 SM cross section



Limit at 1.10 SM xsection

Corresponding to the f

Limits on f totally decided by the systematic uncertainties

Things to do

- Chi2 study, need scanning production on the f planes.
- Angular asymmetry study: May less sensitive than cross sections, need calculate the uncertainties on the angular asymmetry variables.